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(54) METHOD OF WCDMA COVERAGE BASED HANDOVER TRIGGERING

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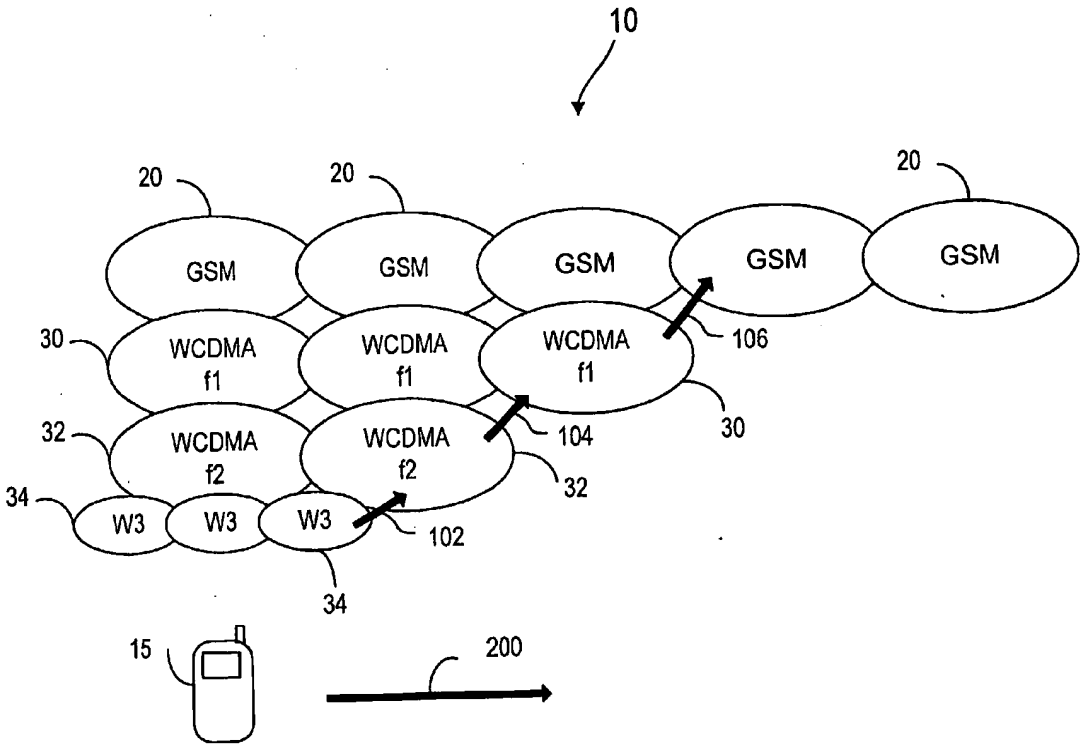
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(57) **ABSTRACT**

A method of triggering an IF or IS handover between two WCDMA carrier or a WCDMA carrier and a GSM carrier. Six triggering conditions are used to initiate the search for an alternative network connection by starting the handover measurements. These triggering conditions are: a) the mobile terminal TxPwr has exceeded its threshold value longer than a specified time; b) the connection based power in the downlink has exceeded its threshold value longer than a specified time; c) the mobile terminal TxPwr has reached the maximum value a specified number of times; d) the SIR target at the base station has risen above a specified threshold value over a period of time; e) the mobile terminal TxPwr has exceeded its threshold value and the gradient of the power control signature indicates sudden rise to maximum power level; and f) the pilot power measured at the mobile terminal has fallen below a threshold value for long than a specified time.



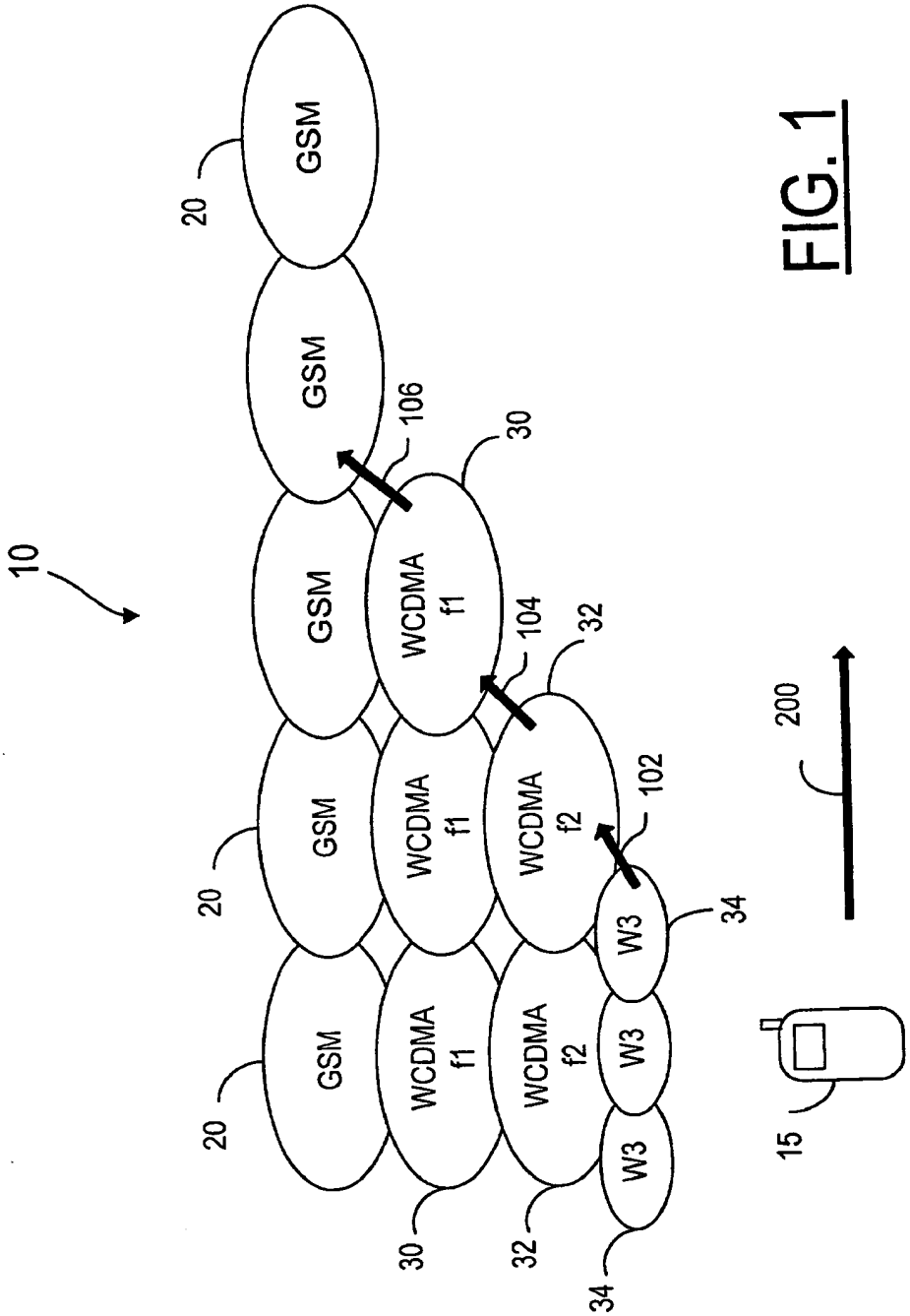

10
GSM
20
GSM
GSM
106
30
WCDMA f1
104
32
GSM
WCDMA f1
WCDMA f2
102
W3
34
GSM
WCDMA f1
WCDMA f2
W3
W3
30
32
34
200
15

FIG. 1

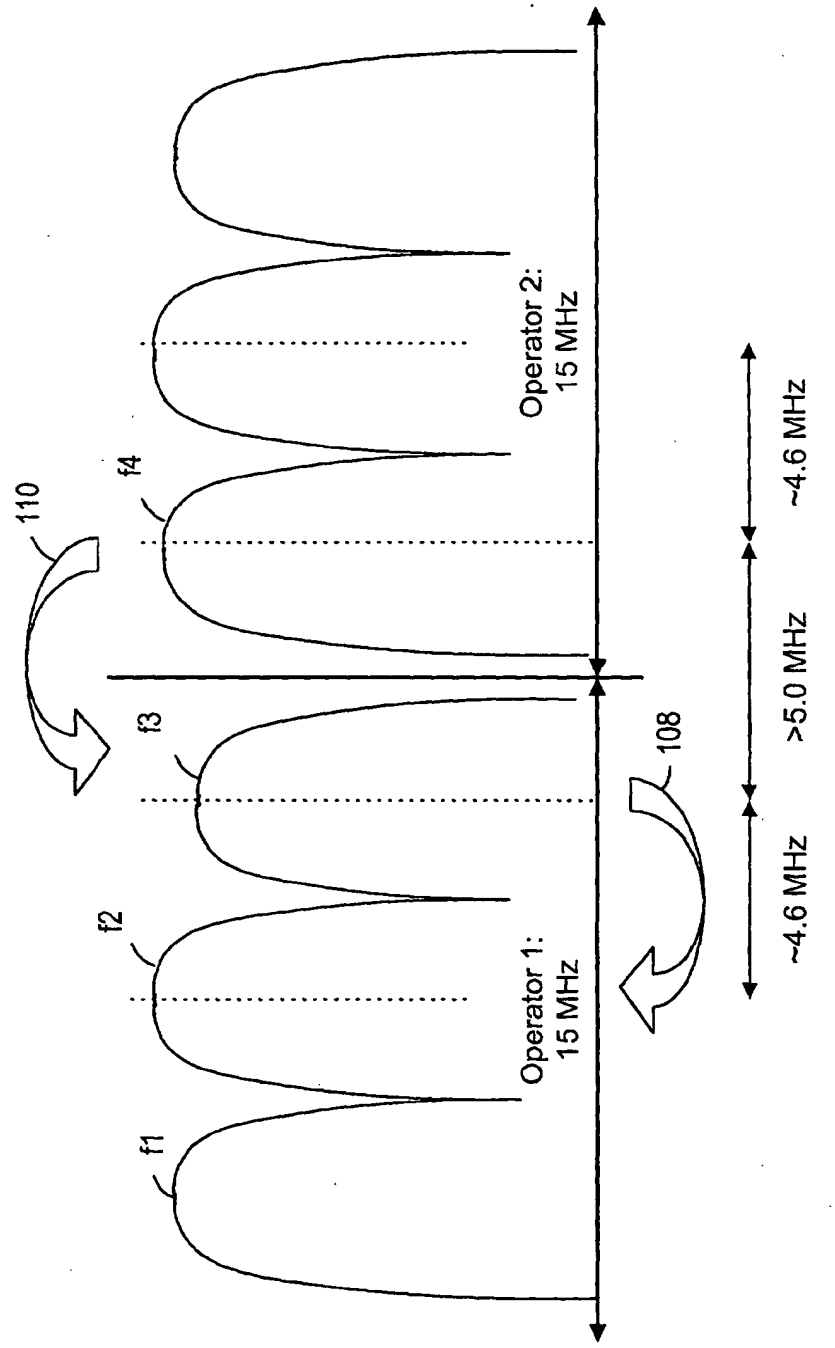

Operator 2:
15 MHz
Operator 1:
15 MHz
f1
f2
f3
f4
110
108
~4.6 MHz
>5.0 MHz
~4.6 MHz

FIG. 2

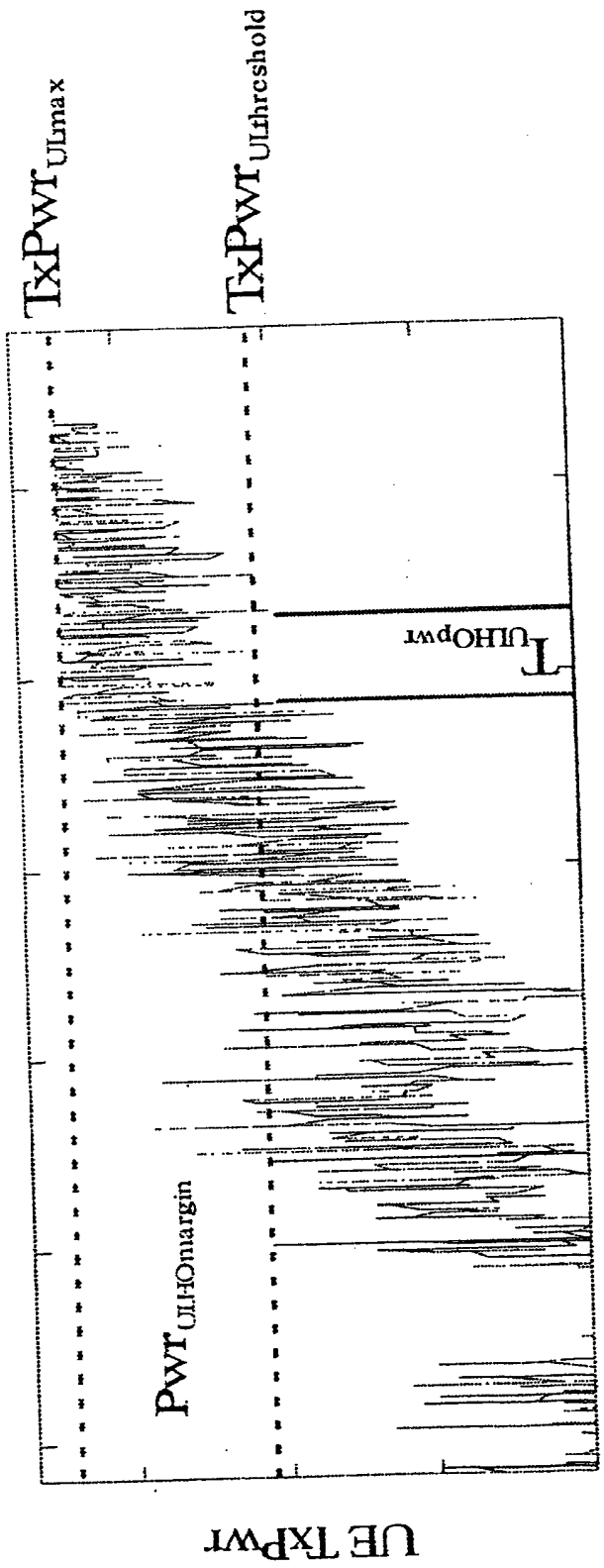

TxPwr ULmax
TxPwr ULthreshold
T ULHOpwr
Pwr ULHOmargin
UE TxPwr
Time

FIG. 3

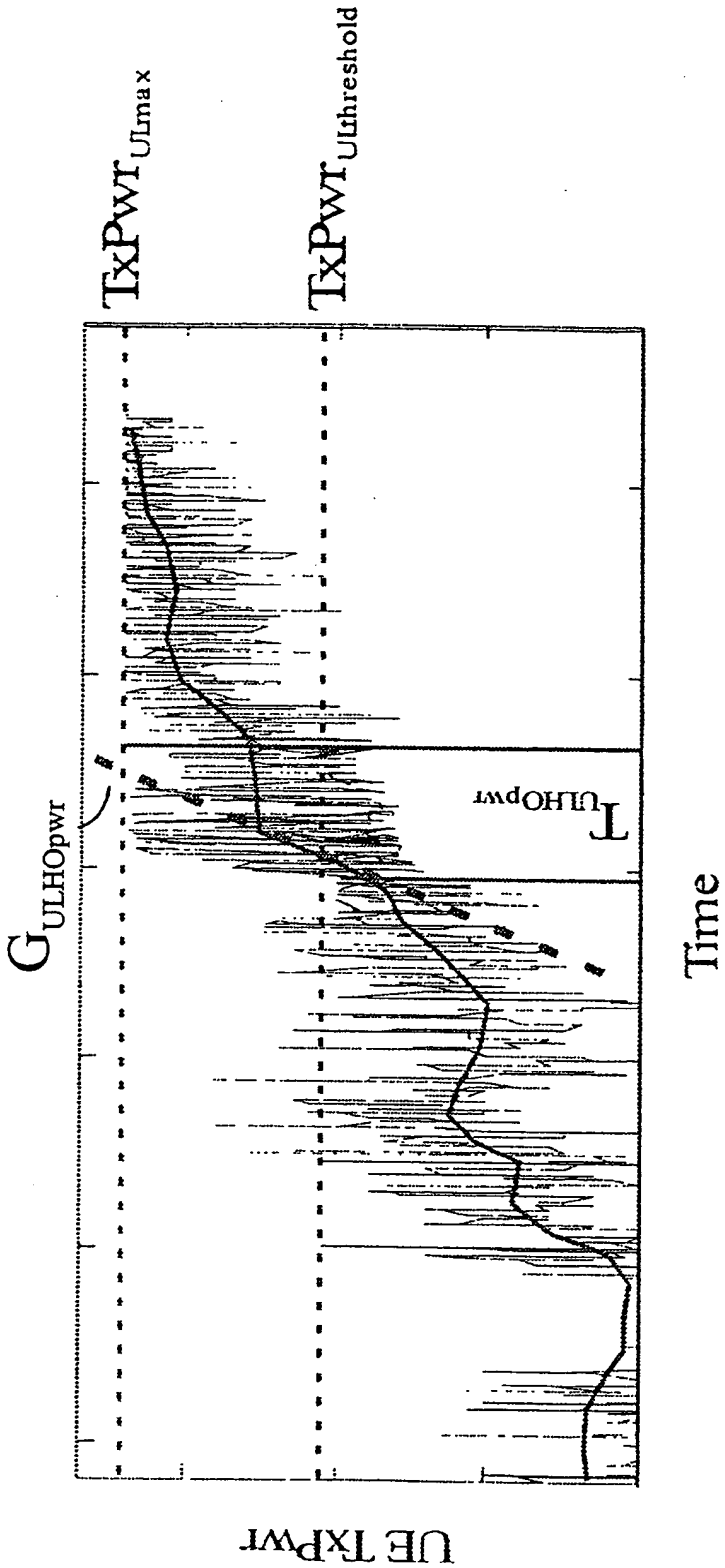

TxPwr ULmax
TxPwr ULthreshold
G ULHOpwr
T ULHOpwr
Time
UE TxPwr

FIG. 4

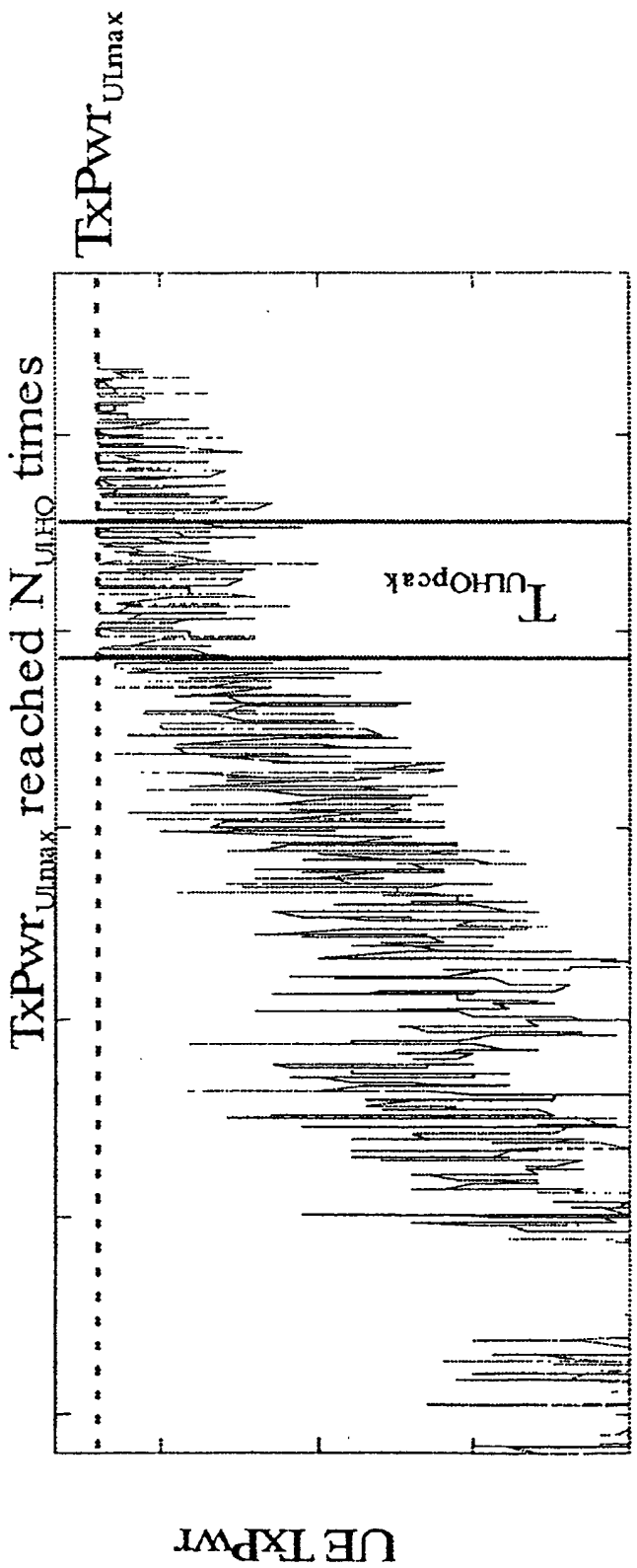

UE TxPwr
TxPwr_ULmax
TxPwr_ULmax reached N_ULHO times
T_ULHOpeak
Time

FIG. 5

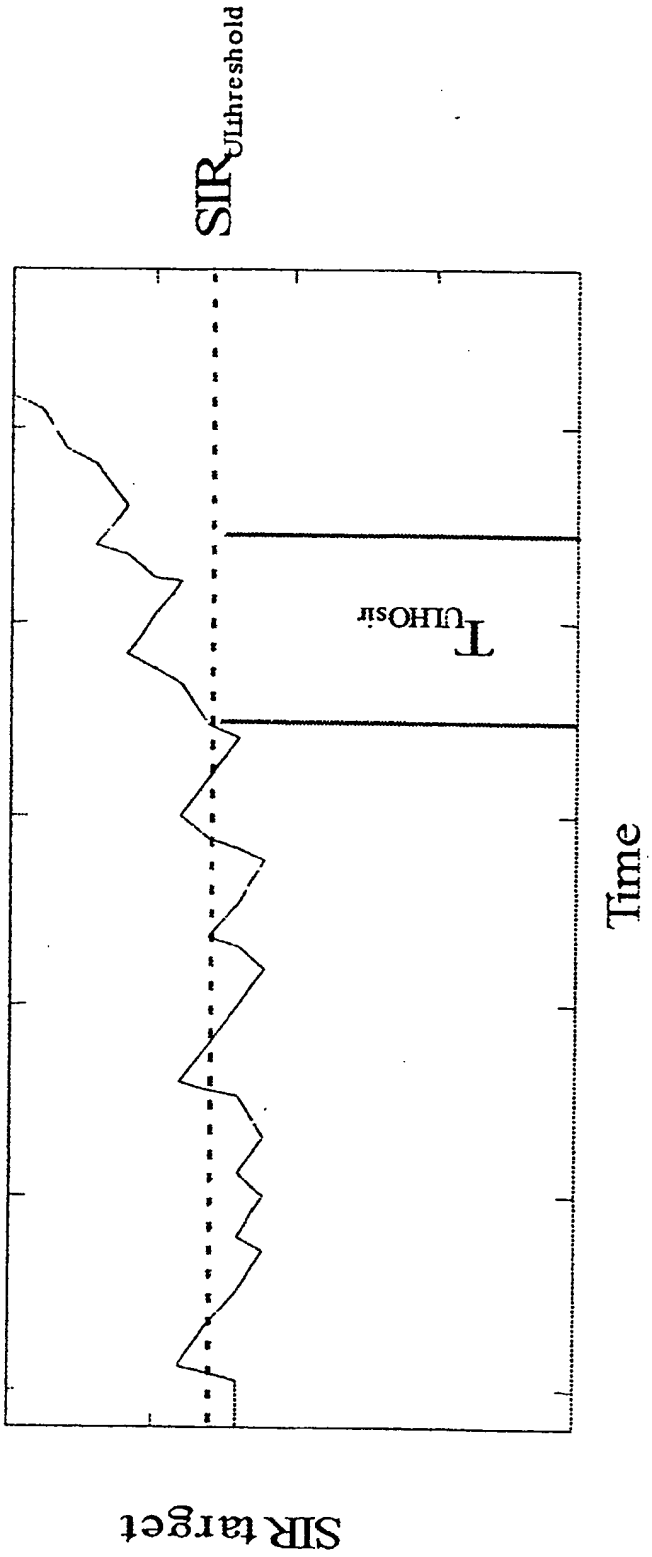


FIG. 6

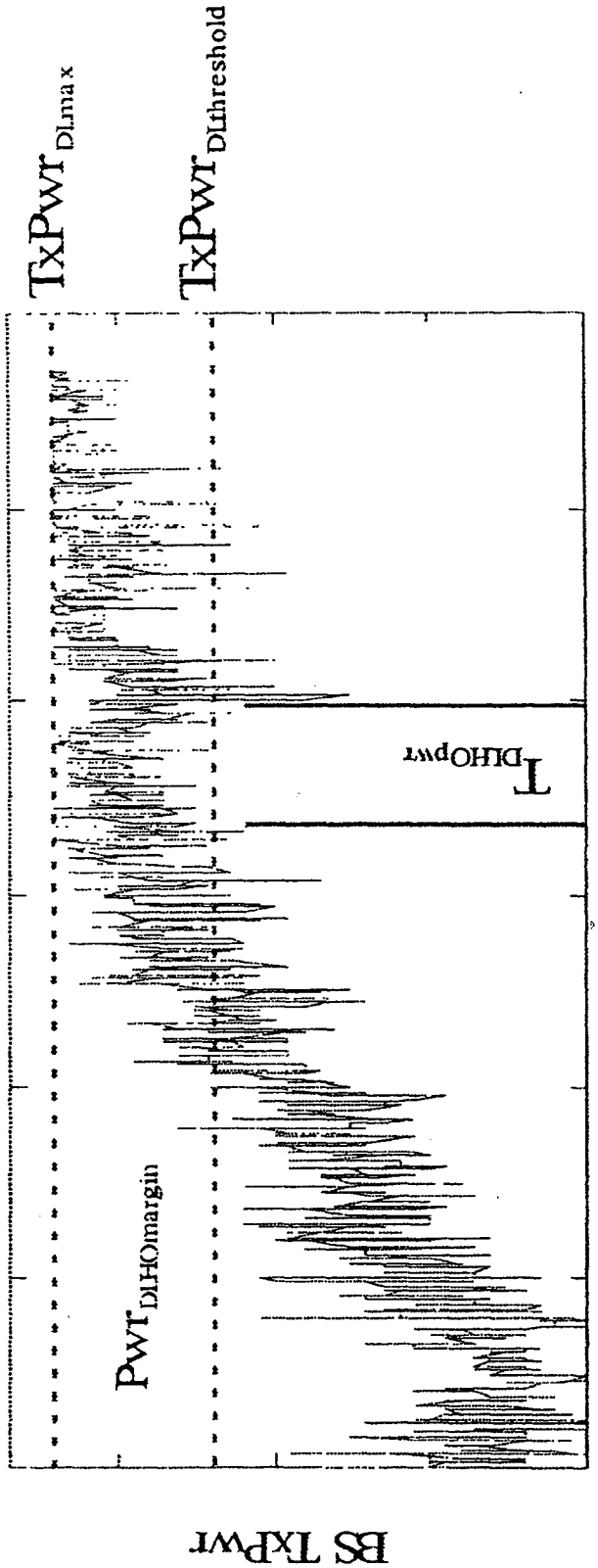

TxPwr DLmax
TxPwr DLthreshold
T DLHOpwr
Time
BS TxPwr
Pwr DLHOmargin

FIG. 7

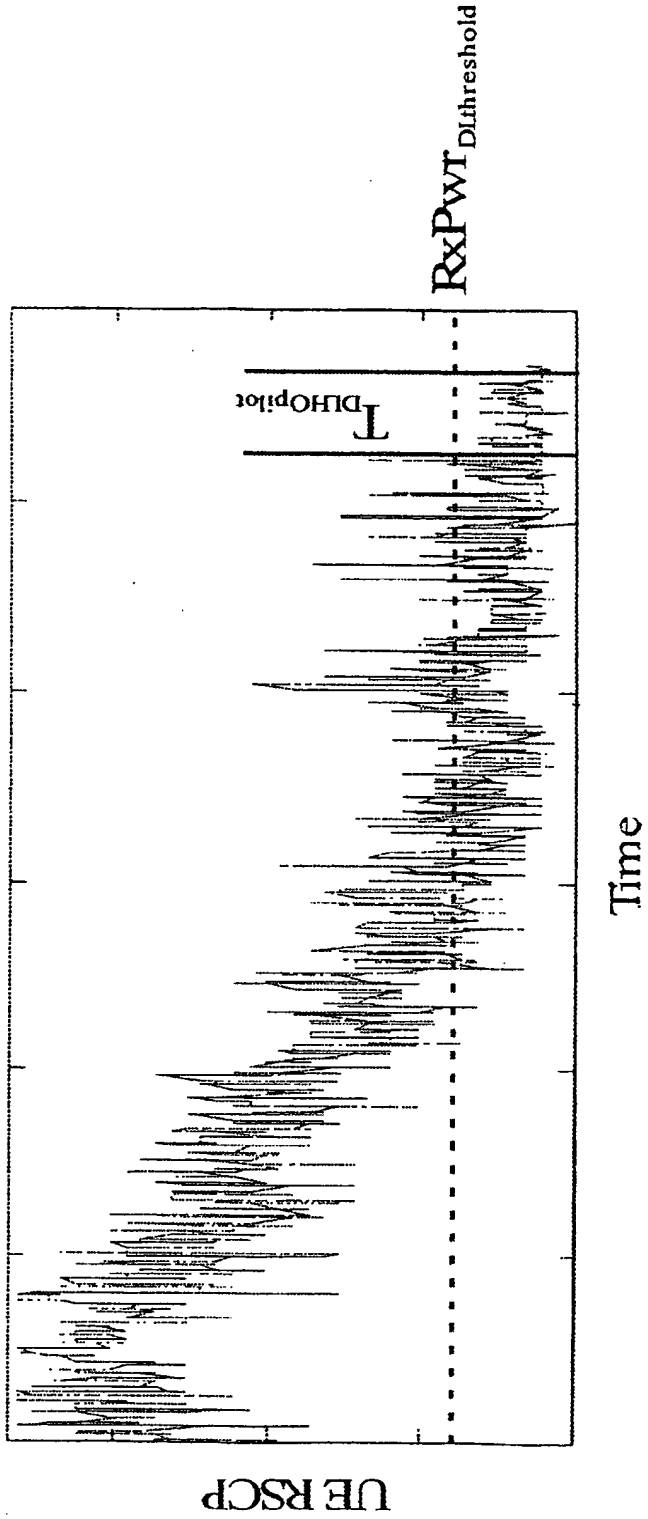


FIG. 8

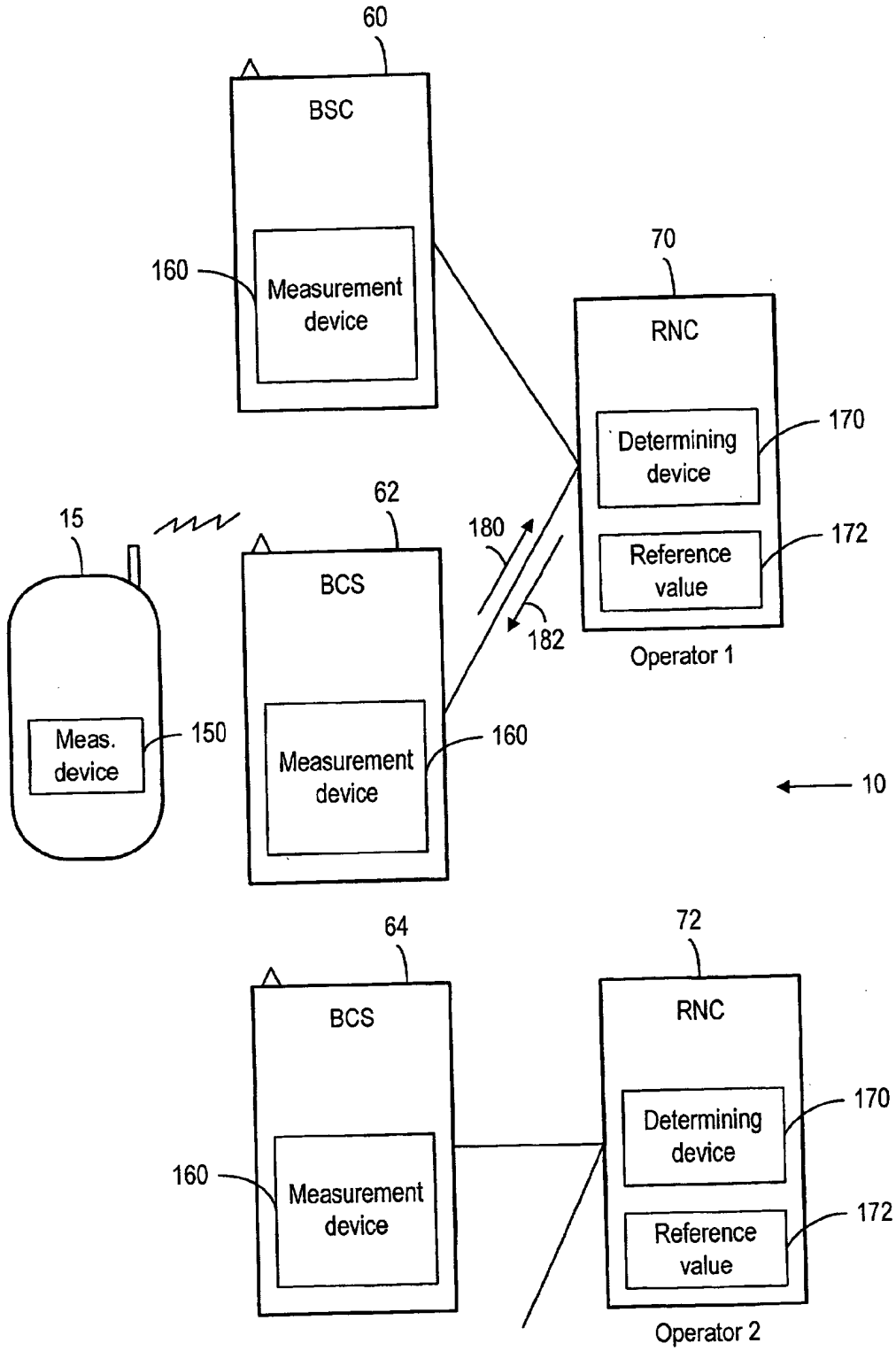

60
BSC
160
Measurement device
70
RNC
Determining device
170
Reference value
172
Operator 1
180
182
62
BCS
15
Meas. device
150
Measurement device
160
10
64
BCS
160
Measurement device
72
RNC
Determining device
170
Reference value
172
Operator 2

FIG. 9

METHOD OF WCDMA COVERAGE BASED HANDOVER TRIGGERING

FIELD OF THE INVENTION

[0001] The present invention generally relates to a mobile telecommunications network and, in particular, to a handover event when a mobile terminal approaches a border of service area of the mobile phone network.

BACKGROUND OF THE INVENTION

[0002] In a mobile phone network, the covering area of an operator is divided into cells. A cell corresponds to the covering area of one transmitter or a small collection of transmitters. When the user of a mobile terminal moves between cells, or the radio coverage areas associated with different base station sites, an ongoing call must be switched to a different radio coverage channel or cell. This is known as handover, or handoff.

[0003] The starting point of the third-generation mobile system, Universal Mobile Telecommunication System (UMTS) is the new radio interface generally known as Universal Terrestrial Radio Access Network (UTRAN), and the GSM/GPRS base core network.

[0004] UTRAN is a conceptual term identifying a part of a radio communication network, wherein a plurality of mobile terminals communicate with each other through one or more base stations. In particular, UTRAN identifies part of the network, which consists of radio network controllers (RNCs) and Node Bs between an interconnection point (Iu) and the radio interface (Uu). The interconnection point (In) is located between an RNC and a core network, and the radio interface (Uu) is located between UTRAN and the user equipment (UE). One of the modes of UTRAN for the user equipment (UE) is the FDD (Frequency-Division Duplex) mode, as distinguished from the time-division duplex (TDD) mode. UE radio transmission and reception (FDD) is described in the Technical Specification (TS) 25.101 v 3.1.0 (1999-12) of the Third Generation Partnership Project (3GPP) and documents referenced therein. UTRAN can operate in two different modes:

[0005] Wideband Code Division Multiple Access (WCDM) mode and Time Division/Code

[0006] Division Multiple Access (TD/CDMA) mode.

[0007] WCDMA has a bandwidth of 5 MHz or more. However, the nominal bandwidth for all third-generation proposals is 5 MHz. In 3G WCDMA mobile radio networks, the primary means for keeping a connection for a mobile station from being dropped while moving between different cells of the network uses a procedure known as handover. Handover can be soft handover (SHO) or hard handover. However, SHO is only operational within one operator network on a single 5 MHz UMTS band. In hard handover, the radio frequency band of the connection between the UE and UTRAN is changed or the cell on the same frequency is changed when no network support of macrodiversity exists. Hard handover is possible when the mobile terminal is in the Cell_DCH state (DCH=dedicated channel) and when SHO is not possible within one frequency band of the 3G network. Hard handover is slower and has a higher risk of failure than SHO. When approaching the edge of the network coverage, the mobile terminal must initiate inter-frequency (IF) or inter-system (IS) measurements in an effort to perform a regular HO.

[0008] As mentioned above, handover is functionality to keep a connection from being dropped while the mobile terminal is moving from one cell to another cell of the network. However, handover can occur due to a change of radio resources providing a service without necessarily any change of base stations involved. In particular, when the radio resources providing a service change from one of the UTRA modes (UTRA-FDD and UTRA-TDD) to another. Handover can also be due to a change of radio systems, from UMTS to GSM, for example.

[0009] In a GSM system, the mobile terminal is the active participant in the handover procedure. The mobile terminal continuously measures the strength of the signal from the serving cell and that of the neighboring cells. The signal strength of the cells can be obtained from the received signal strength indicator (RSSI) measurements of all cells in neighbor list, which is provided by the base station. The signal strength measurements allow the base station controller (BSC) to decide which is the best available cell in order to maintain the quality of the communication link. Two basic algorithms are used for the handover.

[0010] With the "minimum acceptable performance" algorithm, the power level of the mobile terminal is increased as the quality of the transmission decreases. A handover is performed when the power increase no longer has effect on the quality of the signal.

[0011] With the "power budget" algorithm, the handover is performed when the quality of the signal has deteriorated to a certain degree, without continuously increasing the power level.

[0012] When handover is performed from a UTRAN system to a non-UTRAN system, such as GSM, the procedure starts when the UE is receiving the GSM neighbor cell parameters on System Information messages provided on a downlink broadcast control channel (BCCH), or Measurement Control message provided on a downlink dedicated control channel (DCCH). Based on the measurement report from the UE, RNC makes a handover decision. Similarly, when handover is performed from a non-UTRAN system to UTRAN, the procedure starts when the dual-mode UE is receiving the UTRAN neighbor cell parameters on GSM System Information messages. After receiving the measurement report, the GSM BSC makes a handover decision. In GSM, the UE can make inter-system measurements all the time in the same way as normal intra-GSM measurements.

[0013] For WCDMA soft handovers, the mobile terminal continuously makes measurements on other cells. For IF and IS handovers, the RNC needs to initiate the measurements by the mobile terminal. Thus, the mobile terminal will not make measurements unless it is particularly commanded. It is desirable and advantageous to provide a method for triggering an IF or IS handover to ensure continuous operation of a mobile terminal as it approaches the border of its current radio network coverage, thereby reducing dropped call rate and improving the quality of a mobile telecommunications network.

SUMMARY OF THE INVENTION

[0014] It is a primary object of the invention to ensure continuous operation of a mobile terminal as it approaches

the border of its current radio network coverage by way of handover. A successful handover sequence will result in the mobile terminal terminating connection to the original base station and continuing the call at another frequency using the same network system or a different network system. This objective can be achieved by determining in a reliable fashion a point at which the mobile terminal should initiate the search for an alternative network connection by starting the handover measurements.

[0015] Accordingly, the present invention provides a method of triggering a handover event in telecommunication networks having a plurality of base stations operated by a plurality of network operators each having one or more frequency carriers, wherein the handover event is used in a frequency division multiplex (FDD) mode of a mobile terminal capable of communicating with one or more base stations of the telecommunication networks over corresponding uplink and downlink, for allowing the mobile terminal to move from the radio coverage area of a first frequency carrier to the radio coverage area of a second frequency carrier while maintaining communication with one or more base stations, wherein the handover event is performed based on signal strength and/or signal quality measurement, said method comprising the steps of:

[0016] obtaining a first signal indicative of a triggering parameter;

[0017] determining from the first signal whether the triggering parameter has fulfilled a triggering condition regarding a reference value; and

[0018] providing a second signal when the triggering parameter has fulfilled the triggering condition for starting the signal strength and/or signal quality measurement.

[0019] The triggering parameter can be indicative of a transmission power of the mobile terminal in the uplink, and the reference value is indicative of a threshold value for the transmission power, and wherein the triggering condition is fulfilled when the transmission power has exceeded the threshold value over a predetermined period of time.

[0020] Alternatively, the triggering parameter is indicative of a transmission power in the downlink to the mobile terminal, and the reference value is indicative of a threshold value of the transmission power, and wherein the triggering condition is fulfilled when the transmission power has exceeded the threshold value over a predetermined period of time.

[0021] Alternatively, the triggering parameter is indicative of a transmission power of the mobile terminal and the reference value is a maximum value of the transmission power, and wherein the triggering condition is fulfilled when the transmission power has reached the maximum value over a predetermined number of times during a predetermined period of time.

[0022] Alternatively, the triggering parameter is indicative of an uplink signal-to-interference ratio (SIR) targeted at one of the base stations, and the reference value is indicative of a threshold value of the SIR, and wherein the triggering condition is fulfilled when the targeted SIR has exceeded the threshold value over a predetermined period of time.

[0023] Alternatively, the triggering parameter is indicative of a transmission power of the mobile terminal, and the reference value is indicative of a threshold value of the transmission power, and wherein the triggering condition is fulfilled when the transmission power has exceeded the threshold value and an average of the transmission power over a period of time indicates that the transmission power is capable of reaching a maximum transmission power within a predetermined period of time.

[0024] Alternatively, the triggering parameter is indicative of a ratio of a received signal power to a received signal strength indicator, and the reference value is indicative of a threshold value for the receiver signal power, and wherein the triggering condition is fulfilled when the ratio has fallen below the threshold value over a predetermined period of time.

[0025] Preferably, the mobile terminal comprises at least two receivers.

[0026] Alternatively, the mobile terminal has only one receiver and the signal strength and/or signal quality measurement is carried out in a compressed data transmission mode.

[0027] Preferably, when the mobile terminal has only one receiver, the first network operator has at least one radio network controller for connecting one or more base stations to the telecommunication networks, and wherein the second signal is conveyed from the mobile terminal to the radio network controller for the radio network controller to activate the compressed data transmission mode in the mobile terminal.

[0028] Preferably, the aforementioned threshold values can be type specific for macro-cellular networks, micro-cellular networks and pico-cellular networks. Macro cells are outdoor cells with a large cell radius, typically a few tens of kilometers. The cell radius can be extended by the use of directional antennas or repeaters. Micro cells are smaller outdoor cells with a radius of up to 1 kilometer. Pico cells are mainly indoor cells with a radius typically less than 50 meters.

[0029] The present invention will become apparent upon reading the description taken in conjunction with FIGS. 1 to 9.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030] **FIG. 1** is a diagrammatic representation illustrating the various situations where a handover is necessary.

[0031] **FIG. 2** is a diagrammatic representation illustrating another situation where a handover is desirable.

[0032] **FIG. 3** is a diagrammatic representation illustrating the transmission power of the mobile terminal as a function of time.

[0033] **FIG. 4** is a diagrammatic representation illustrating the transmission power of the mobile terminal, as shown in **FIG. 3**, but for a different triggering criterion.

[0034] **FIG. 5** is a diagrammatic representation illustrating the transmission power of the mobile terminal, as shown in **FIG. 3**, but for yet another triggering criterion.